

Equations, Function Tables and Graphs: Tools for Building School Store Success

Brief Overview:

Using function tables and algebraic expressions, students will plan and operate a school store to raise money for a field trip. Students will learn about variables, expressions, equations, function tables and rules, and line graphs as they move from concrete models to abstract thinking.

NCTM Content Standard/National Science Education Standard:

Represent and analyze mathematical situations and structures using algebraic symbols

- **Represent the idea of a variable as an unknown quantity using a letter or a symbol**
- **Express mathematical relationships using equations.**

Use mathematical models to represent and understand quantitative relationships

- **Model problem situations with objects and use representations such as graphs, tables, and equations to draw conclusions.**

Analyze change in various contexts

- **Investigate how a change in one variable relates to a change in a second variable.**

Grade/Level:

Grade 5

Duration/Length:

This unit consists of three 60-minute lessons.

Student Outcomes:

- **Students will explore ways to use variables as symbols to represent numbers in expressions and equations**
- **Students will model problem-solving situations with objects and use representations such as function tables, graphs, and equations to draw conclusions.**
- **Students will investigate how a change in one variable relates to a change in a second variable.**

Materials and Resources:

Day 1

- Math Journals or blank paper
- Variable Machines
- Vocabulary Definitions
- Calculators
- Colored counters

Day 2

- Glue sticks or tape
- Scissors

Day 3

- Colored pencils
- Rulers

Lesson 1: Variety is the Spice of Life: Using Variables in Expressions and Equations

Advanced Preparation

- Create a variable machine found on Teacher Resource 1 for each student. “The Variable Machine” was adapted from *Navigating through Algebra in Grades 3-5*, pp 39-40. Variable machines can be copied on color paper for added interest. You will need enough for each student.
- Post the definitions of the vocabulary words found on Teacher Resource 2.
- Optional: Display colorful pictures or posters from the location of your field trip, to generate excitement.

Launch for the Unit

- Begin the lesson by explaining the context for the unit.
- Say to students: We’re going to Philadelphia in May! ... If we raise enough money for the bus.
- Say to students: We need \$2,000 pay for the busses. We have already raised \$1,750 and we only have 1 month to raise the rest of the money. How much more money do we need?
- Call on a student to explain how to subtract $\$2,000 - \$1,750 = \$250$.
- Say to students: The fifth grade teachers have decided to help you set up a school store to earn the money. All profits from the school store will go towards paying for our field trip to Philadelphia. In order to create a school store, we need to decide what to sell, how much of each item to order, and how much profit each item will generate. Then we will compare the profits of the different items to see how much of each item to sell, and make predictions about which will be more profitable as sales increase.
- Tell students they will learn to use variables, algebraic expressions, equations, function tables, and graphs to plan and operate the store.

- Say to students: We're going to start by looking at variables in algebraic expressions and equations.

Pre-assessment and Launch

- Distribute the “What is a Variable?” pre-assessment (cut in half) to each student (Student Resource 1). The answers are included on Teacher Resource 3.
- Allow 5 minutes to complete the pre-assessment.
- After 5 minutes, randomly select a few students to share how they reached their answers. Allow students to display their thinking on the front board or using an overhead projector.

Teacher Facilitation

Part 1: What is a Variable?

- Ask students: What is a variable? What does the word vary mean?
- Select a few students to share their thinking.
- Post the definition of variable.
- Say to students: It means change. In math we sometimes use letters or symbols as variables to stand for numbers that can change, or numbers that are unknown in a problem. What are some letters you have seen used as variables? (n, x, y, l, w, b, or h are some examples)
- One way to show how this can work is with a “Variable Machine” (Teacher Resource 1).
- Distribute a “Variable Machine” to each student and tell students to turn to an empty page in their math journals, or on blank paper.
- Say to students: Line up the number 1 with the letter A. Look for the first letter of your first name, and see which number is next to it. Write that down. Continue writing your name in numbers by looking for the letters and matching them with the corresponding numbers. When they are all written down, add them together to find the “value” of your name. You may use a calculator to help you find the sum if needed.
- Select a few students to share the value of their names.
- Say to students: Now turn the number strip so that the number ‘1’ lines up with a letter other than A. Now find the value of your name.
- Select a few students to share the value of their names.
- Say to students: How did the value of your name change? Why did it change?
- Student answers should reflect that variables (letters) can stand for changing quantities or different numbers, depending upon the situation.
- Note: You can differentiate this activity by using different number strips with higher numbers, or decimals depending on the needs of

your students. Teacher Resource 2 provides examples of different number strips for “Variable Machines.”

Part 2: How are variables used in expressions and equations?

Teacher Facilitation

- Say to students: Algebraic expressions and equations use variables as a symbol that can represent any member of a set of numbers. If you have an expression or an equation that contains a variable, you can substitute different numbers for the variable and it will affect your outcome. To evaluate or solve these expressions, we substitute values for the variable and calculate the result.
- Post the definitions of algebraic expressions and equations in Teacher Resource 2.
- Say to students: For example, if we have twice as many pencils as erasers, we can write an expression to show this. I am going to use “e” as a variable to represent the number of erasers. The expression to show how many pencils we have would then be $2 \times e$, $2 \cdot e$ or $2e$.
- Display your thinking as you model.
- Say to students: We can also write an equation or a number sentence to show the relationship between pencils and erasers. I am going to use “p” to represent the number of pencils. $2e = p$.
- Display your thinking as you model.
- Say to students: We will be using variables to write some expressions and equations that will help us make decisions about our school store. Let’s look at some examples.
- Say to students: Ben spent \$2.50 more than Debbie in the store. Write an expression to show how much Ben spent. Remember, an expression does not have an equal sign.
- Select a student to share his/her answer. Make sure the student explains what each variable represents. (If D =Debbie, then $D+\$2.50$)
- Now write an equation to show the relationship between how much Ben spent and how much Debbie spent at the school store.
- Select a student to share his/her answer. Make sure the student explains what each variable represents. (If B =Ben and D =Debbie then $D+\$2.50=B$)
- Say to students: Let’s try another example. The school store sold 12 more lanyards on Thursday than on Wednesday. Write an expression and an equation to show how many lanyards were sold on Wednesday.
- Select a student to share his/her answer. Make sure the student explains what each variable represents. (If W =Wednesday and T =Thursday, then $T-12$ is the expression. $T-12=W$ or $W+12=T$ is the equation.

Student Application

- Students will use what they are learning to solve problem stories. Pose these problems verbally and have students write their responses in their journals.
- The price of water bottles is \$.40 less than the price of science fair boards. Write an expression to show the price of water bottles.
- The price of lanyards is $\frac{1}{2}$ the price of water bottles.
- The store sold 3 times as many lanyards as science fair boards.
- Sammy bought pencils and lanyards. He bought $\frac{3}{4}$ as many pencils as lanyards.
- Students will work in small groups to solve the “Sales Each Day” story problems on Student Resource 2a-b. The answers are found on Teacher Resource 4a-c.

Teacher Facilitation

- Summarize variables, expressions and equations by reviewing the definitions with students.
- Tell students that in the next lesson we will apply variables, expressions and equations to help us set up our school store and take a look at the profits we can make.

Embedded Assessment

- As you work through the problems with the full group you will be able to check student understanding of the vocabulary words and you will see if students can apply the definitions to writing expressions and equations.
- The story problems will provide assessments of student application of their learning.

Reteaching

- For those who have not completely understood the lesson, encourage them to use counters and other manipulatives to help them work through problems. Have them write the vocabulary words in their journals, along with examples to illustrate the terms that they can easily refer back to.

Extension

- For those who have understood the lesson, pose more complex stories using fractions and decimals.

Lesson 2: Setting Up the Store

Advanced Preparation

- Enlarge 4 copies of the blank function table found in Teacher Resource 5 or draw them on 4 poster boards or large sheets of paper.
- Make copies of Teacher Resource 6 containing pictures of school store items and Teacher Resource 7 containing pictures of money. (one set per group)

Pre-Assessment

- Group students in pairs.
- Distribute the “How Many Pencils Did We Sell” Variable Review pre-assessment (Student Resource 3) to each pair. The answers are included on Teacher Resource 8.
- Give each pair 5 minutes to complete the pre-assessment.
- Circulate among the groups and assist where needed.
- After 5 minutes, randomly select a few students to share how they reached their answers. Allow students to display their thinking on the front board or using an overhead projector.

Launch

- Ask the class what items they want to sell at the school store.
- Explain that this school store will sell: Pencils, fun Pencil Toppers, Science Fair Boards, school spirit Water Bottles, and Lanyards with the school name on them.
- Note to teachers: Feel free to change the location or time of the field trip and/or the items sold in the school store to fit your own situation.

Teacher Facilitation

- Show the profitability chart, which is Teacher Resource 9. Explain that profit is the amount of money the item sells for minus the amount it cost.
- Display the blank function table for pencils (Teacher Resource 10a). The answer page is Teacher Resource 10b.
- Model how to use a function table to figure out how much money the school store can make selling pencils. Use the pictures of the items (Teacher Resource 6 and coins found in Teacher Resource 7 for this activity.)
- Say to students: If I look on the chart, I see that for every pencil sold, the school store makes 10¢.

- Place one pencil icon under input and one dime icon under output.
- Say to students: If we sell 2 pencils, the profit is 20¢ because 2 times 10 is 20.
- Place two pencil icons under input and two dime icons under output.
- Put up 5 pencil icons under input and put 2 quarters (or 5 dimes) under output.
- Say to students: How many pencils do you think one student might buy? [sample student response is 8]
- Place eight pencils on the function table under input, and continue to model how to find the output using a think aloud.
- Say to students: What rule represents the relationship between the number of pencils sold, which is the input, and the profit, which is the output? (Input \times \$0.10 = Output) What equation can we write to help us apply the rule? ($\$0.10x = y$, where x = the number of items sold; y = the profit)
- Say to students: Using the rule we just created, solve the following problem. If we wanted to make a profit \$2.50, how many pencils would we need to sell? (25)
- Call on one or two students to explain how they arrived at the answer.

Student Application

- Divide the class into 4 groups and distribute Student Resource 4a-d.
- Assign each group an item to sell: pencil toppers, water bottles, lanyards, or science fair boards.
- Give each group copies of the pictures of their item and the pictures of coins.
- Distribute glue sticks or tape, scissors, and the large function tables.
- Allow each group eight minutes to complete the function table, create a rule and write an equation for calculating Output.
- Call on each group to share their function table with the class and explain their thinking. Clarify any misconceptions.

Teacher Facilitation

- While students are working, circulate and help as needed.
- After each group has completed their chart, display them in the front of the room and keep them posted throughout the unit for reference.
- Use the Rule and Sales Tracking Chart (Blank copy is Teacher Resource 11a; Answer key is Teacher Resource 11b) to have the class write the rules they generated. Students can use Student Resource 5 to fill in the information being generated.
- First, as a class, fill in all the rules that were generated.

- Tell students that in the first week the store sold Pencils: 150; Pencil Toppers: 100; Lanyards: 18; Water Bottles: 25; Science Fair Boards: 12. Put those numbers onto the Rule and Sales Tracking Chart.
- Using the rules, have students complete the last column in the chart showing profit for each item.
- Summarize by discussing how they have used variables, expressions and equations to write a rule for their function tables. Discuss how we can extend that rule to predict what will happen as sales increase, or as the variable in the Input column changes.
- Ask students to keep these charts for use in the next lesson.

Embedded Assessment

- Teacher observation of student understanding of completing function tables and creating a rule while working in cooperative groups.

Lesson 3: It's Time to Make More Money - Graphing Equations and Analyzing Results

Pre-Assessment

- Distribute the Function Tables and Rules Review Student Resource 6 to each student. The answers are found on Teacher Resource 12.
- Say to Students: You have 5 minutes to complete this exercise.
- Select a few students to share their thinking.

Launch

- Display the function tables created in Lesson 2 for profitability of pencils, pencil toppers, lanyards, water bottles, and science fair boards.
- Using an overhead of the blank graph for Pencils, (Teacher Resource 14a) ask students to help you analyze the graph. (Teacher Resource 14b is a completed graph.)
- Say to Students: Look at the function tables completed yesterday. Ask them which part of the graph refers to the Input column (X) in the function tables. Which part of the graph refers to the Output column (Y) in the function tables?
- Model how to look at the Input and Output results and match the points plotted on the line graph to the graph.

- Fill in the blank lines on the title and the x-axis on the graph.
- Say to Students: Now it is your turn to match the graph to the correct function table. Be ready to explain your thinking to the class when you are done.
- Distribute Student Resource 7a-b to each group and allow them 5 minutes to identify and label the other 4 graphs in groups. Answers can be found in Teacher Resource 13a-c.
- Allow one student from each group to present their results.
- Tell students you are going to now use these graphs to see how the school store can make more money in less time.

Teacher Facilitation

- Say to Students: Out of all the items the school store is selling, pencils are the most popular. After all, every student needs a pencil. What variable could we change to make pencils a more profitable item for us to sell? As you guide the discussion, be sure you refer back to the function tables. (Expected response: sell pencils for a higher price so they are more profitable.)
- Say to Students: Look at the original rule. What part of the rule can we change? What effect would that have?
- Select a few students to share their suggestions about what to change. Guide them to want to change the profit margin. Remind students that the new price cannot be so high that students will not want to purchase the pencil. For example, no one would buy the pencil for \$100. Suggest that if we change the profit on pencils to \$.25, we would now have to sell them for \$0.40.
- Say to Students: How would changing the selling price of the pencils change the graph?
- Create a new function table quickly using Teacher Resource 15. Plot the new data in a different color or using different shaped points on the Pencil line graph you just created. (Teacher Resource 14b). Using a think aloud, explain how the slope of the line has changed and risen more quickly.
- Say to the Students: On the first line, if we wanted to make a profit of \$1.00 selling pencils, we had to sell 10 pencils, because we only made \$0.10 on each pencil. Now let's look at the new line. On the new line if we want a profit of \$1.00 how many pencils did we have to sell? (4) Was our goal of \$1.00 reached more quickly? (Yes) Does the line graph show this clearly?
- Explain why or why not using details from the graph. (Yes, because the slope of the second line is steeper than the slope of the first line. The steeper the slope, the quicker the y-axis value increases. Another good response is the first line shows a profit of \$1 after 10 pencils were

sold, but the second line shows a profit of \$1 after only 4 items were sold.)

Student Application

- **Students work in the same groups they were in for Lesson 2. Distribute one Blank Function Table (Student Resource 8) to each group.**
- **Say to the Students: Each group will now choose a new profit amount for one of the other 4 items in the store. Remind the students that the new price must be reasonable, and not so high that sales will dramatically decrease. Create a new function table showing the new profits, and write a new rule in the form of an equation. Next plot that new data onto the original line graph, in a different color, so the profit lines can be compared. Do not forget to add a key.**
- **After completion have each group post their results in the front for the room and share them with the class.**

Teacher Facilitation

- **Say to the Students: During this unit, we have used equations, function tables and graphs to analyze and make decisions about our school store. Looking at all the displays we made on pencils, would you rather use the graph, the rule or the table to find out how many pencils you had to sell to earn a profit of \$.70? Sample Answer: it's easier to locate \$.70 on the graph quickly. (Your function table does not have to include all the values, so there could be gaps. You could calculate it using the rule, but on the graph you can see it easily.)**
- **Say to the Students: Would you use a graph, table or rule to find out how much profit you'd make if you sold 55 pencils? (Since the graph doesn't extend that far it would be easier to use the rule and table to calculate that. It's easier to use the rule and table to make predictions about amounts beyond what's on the chart. That's what makes it a useful prediction tool.)**
- **Summarize the lesson by asking students several of the following questions. Clarify any misconceptions when needed. Encourage students to use data from the tables, graphs and rule to support their answers. Some discussion questions are:**
- **If you want to make predictions about what will happen when we sell larger quantities of the items, how can we use our new algebra tools to predict the results?**

- How we can change variables to change our results, or reach our goals more quickly?
- How do variables, function tables, expressions and graphs help us analyze real world situations and make choices?
- What other things can we do to the school store to earn more money? (Expected responses: such as sell more of an item to make more profit; sell fewer but more profitable items.)

Summative Assessment

- Use “Bringing it All Together” (Student Resource 9; answers found on Teacher Resource 16) to lead a discussion about how these tools can help students track the results of their school store. Explain that as the store continues to sell items, they will be able to see how much profit is generated each day and how many days it will take them to reach their goal of \$250. Discuss the changes they could make to reach the goal more quickly.
- Let’s try an example. If our store has been open for 1 week and we sold the following amounts, how long would it take us to reach our goal of raising \$250?
- Pencils: 150; Pencil Toppers: 100; Lanyards: 18; Water Bottles: 25; Science Fair Boards: 12
- Ask: What’s the first thing we have to do to see how much money we earned this week? (Apply the rules to calculate the profits.)
- Distribute “Bringing it All Together” (Student Resource 9) and as a class apply the rules and equations to show sales for the week.
- The results will show that Pencil Toppers earned \$13.00 profit; Science Fair Boards earned \$12.00; Water Bottles earned \$15.00; Lanyards earned \$13.50; and Pencils earned \$15.00.
- Point out that even though we didn’t sell as many lanyards as pencil toppers, because of the difference in profit margins, they both brought in almost the same amount. We sold 15 water bottles and 150 pencils but both generated the same amount of earnings because of the profit margins.
- Say to students: Adding it all together, we see that in this week we earned \$68.50. Our goal is to earn \$250.00. Divide 250 by 68.50 to see how long it will take. It would take almost 4 weeks.
- But we want to earn this in 2 weeks, so without changing the sales numbers, using our decisions on changing profitability that we graphed, will we earn the money more quickly?
- Can you see how you can use this information and these tools to decide the selling price and profit margins for items to help you reach your goals?

Embedded Assessment –

- **Teacher observation of student understanding of graphing equations using variables and how a change in one variable affects the second variable while working in cooperative groups.**

Reteaching

- **For students who are having difficulty with creating line graphs from function tables, use Student Resource 10 (Answers are found in Teacher Resource 17) to play a game matching equations to the corresponding function tables and graphs. For similar activities go to www.bbc.co.uk/education/mathsfile.**

Extension

- **One extension can be to ingrate the process of science with mathematics.**
- **Say to Students: In science, we also use the words variables. What is an independent variable? (a variable you have no control over) What is a dependent variable? (the results or a variable that changes as a result of another variable.)**
- **Say to Students: Now take a look at our function table and graph of pencil profits. Using what you know about independent and dependent variables in science, which variable is independent and which variable is dependent? (Since the profit changes for each pencil sold, the profit or Y is the dependent variable. We had no control over how many pencils were sold so that is the independent variable.)**

Summative Assessment:

- **The Summative Assessment is Student Resources 11a-c. The Answer Key is Teacher Resources 18a-c (answers to be filled in for November). The Rubric is Teacher Resource 19.**

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What is a Variable?

Name: _____

What is a variable?

Alan bought 6 erasers more than Sara. Use a variable to write an expression showing how many erasers Alan bought.

What is a Variable?

Name: _____

What is a variable?

Alan bought 6 erasers more than Sara. Use a variable to write an expression showing how many erasers Alan bought.

Sales Each Day Story Problems

The School Store sold a certain number of pencils, eraser toppers and lanyards each day. Looking at our store sales results, you can see how many total items sold each day. We have given you clues to use to figure out how many of each specific item sold each day. (You may use colored chips or counters to represent the items.)

P = pencils

E = eraser toppers

L = lanyards

1. On Monday The Store Sold:

3 pencils

2 more eraser toppers than pencils

15 items in all

Write an equation using variables to determine how many eraser toppers and lanyards sold on Monday.

Pencils: _____

Eraser Toppers: _____

Lanyards: _____

2. On Tuesday The Store Sold:

6 pencils

Twice as many lanyards as eraser toppers

12 items in all

Write an equation using variables to determine how many eraser toppers and lanyards sold on Tuesday.

Pencils: _____

Eraser Toppers: _____

Lanyards: _____

3. On Wednesday The Store Sold:
3 pencils
4 times as many eraser toppers as pencils
23 items in all

Write an equation using variables to find the number of eraser toppers and lanyards sold on Wednesday.

Pencils: _____ Eraser Toppers: _____ Lanyards: _____

4. On Thursday The Store Sold:
12 items in all
 $\frac{1}{4}$ of the items were pencils
 $\frac{1}{3}$ were lanyards

Write an equation using variables to find the number of pencils, eraser toppers and lanyards sold on Thursday.

Pencils: _____ Eraser Toppers: _____ Lanyards: _____

5. On Friday The Store Sold:
1 fewer pencil than the number of erasers
1 fewer lanyard than the number of pencils
6 items in all

Write an equation using variables to find the number of pencils, eraser toppers and lanyards sold in all.

Pencils: _____ Eraser Toppers: _____ Lanyards: _____

Variable Review Pre-Assessment
How Many Pencils Did We Sell?

We want to know how many pencils we sold in our school store. Write an equation using variables to help you find out.

Clues:

We sold 6 more Water Bottles than pencils.

We sold 2 times as many erasers as pencils.

We sold 2 lanyards more than the number of erasers.

We sold the same number of science fair boards as Lanyards.

The total amount of items sold in the store was 130. .

Pencils = P

Water Bottles = W

Pencil Toppers = T

Lanyards = L

Science Fair Boards = S

Using the table below, write an expression for each item to show how many we sold.

| Pencils | Water Bottles | Erasers | Lanyards | Science Fair Boards |
|---------|---------------|---------|----------|---------------------|
| | | | | |


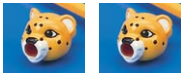

Equation: _____

Solve the Equation and write your answers in the table below.

| Pencils | Water Bottles | Erasers | Lanyards | Science Fair Boards |
|---------|---------------|---------|----------|---------------------|
| | | | | |

Check your answer: _____




Function Table for Pencil Toppers

| INPUT | OUTPUT |
|---|--------|
|  | |
|  | |
|  | |
| | |
| | |

Rule:

Equation:




Function Table for Water Bottles

| INPUT | OUTPUT |
|--|--------|
|  | |
|  | |
|  | |
| | |
| | |

Rule:

Equation:

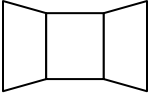
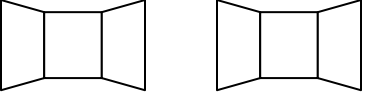
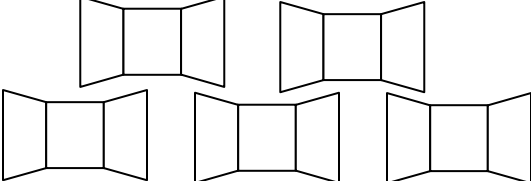
Function Table for Lanyards

| INPUT | OUTPUT |
|---|--------|
|  | |
|  | |
|  | |
| | |
| | |

Rule:

Equation:

Function Table for Science Fair Boards

| INPUT | OUTPUT |
|--|--------|
|  | |
|  | |
|  | |
| | |
| | |

Rule:

Equation:

Student Resource 5

Name: _____

Rule and Sales Tracking Chart

Use this chart to summarize the rules generated for each item. Now we can project profits.

| Item | Starting Profit | Amount Sold in 1 Week | Rule | Equation | Total Profits for Week |
|--------------------------------|-----------------|-----------------------|------|----------|------------------------|
| Pencil (P) | \$0.10 | 150 | | | |
| Pencil Topper (T) | \$0.13 | 100 | | | |
| Water Bottle (W) | \$0.60 | 25 | | | |
| Science Fair Boards (S) | \$1.00 | 12 | | | |
| Lanyard (L) | \$0.75 | 18 | | | |
| Totals | | | | | |

Name: _____

Function Tables and Rules Review

1. Complete the Function Table and write the Rule and Equation.

| Input (x) | Output (y) |
|--------------|---------------|
| 3 | 18 |
| 6 | 36 |
| 12 | |
| | 54 |
| 17 | |

The rule is _____

The equation is _____

2. Complete the Function Table, match the table to the correct Rule, write the Equation.

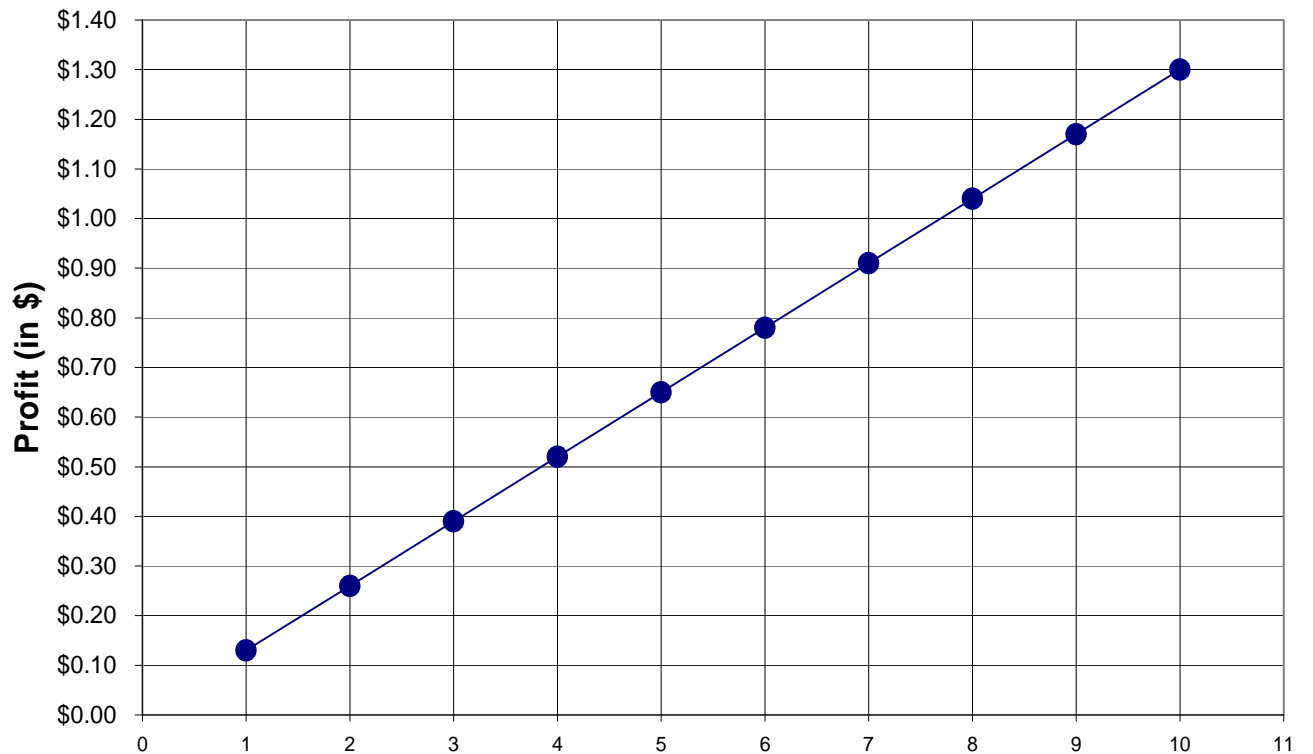
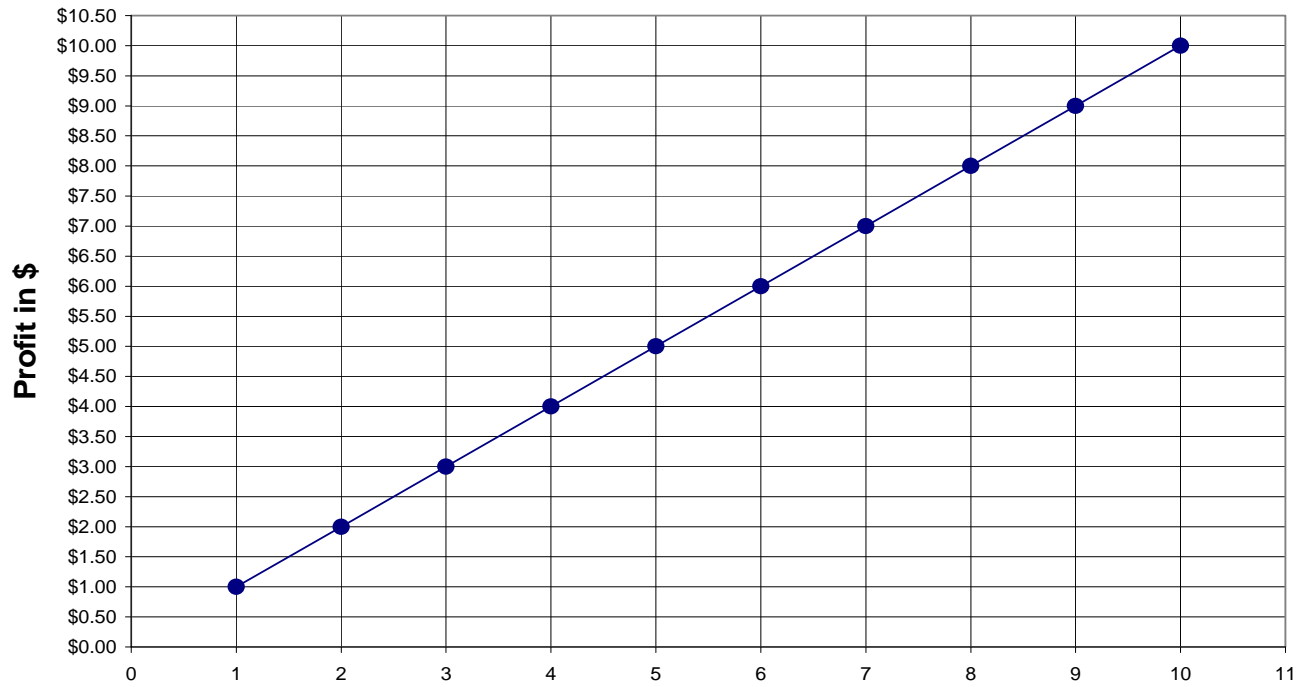
| Input (x) | Output (y) |
|--------------|------------|
| 18 | 7 |
| 26 | 15 |
| | 30 |
| 36 | |
| | 14 |
| 57 | |

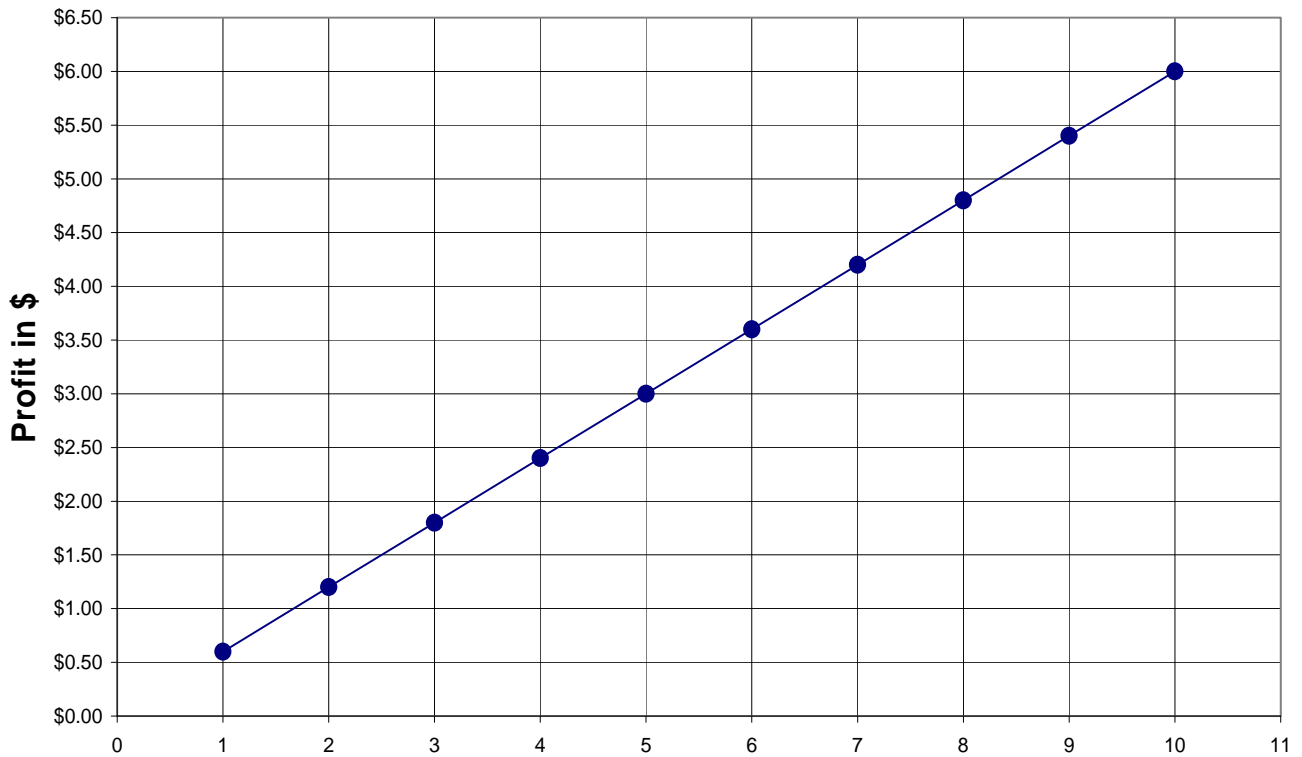
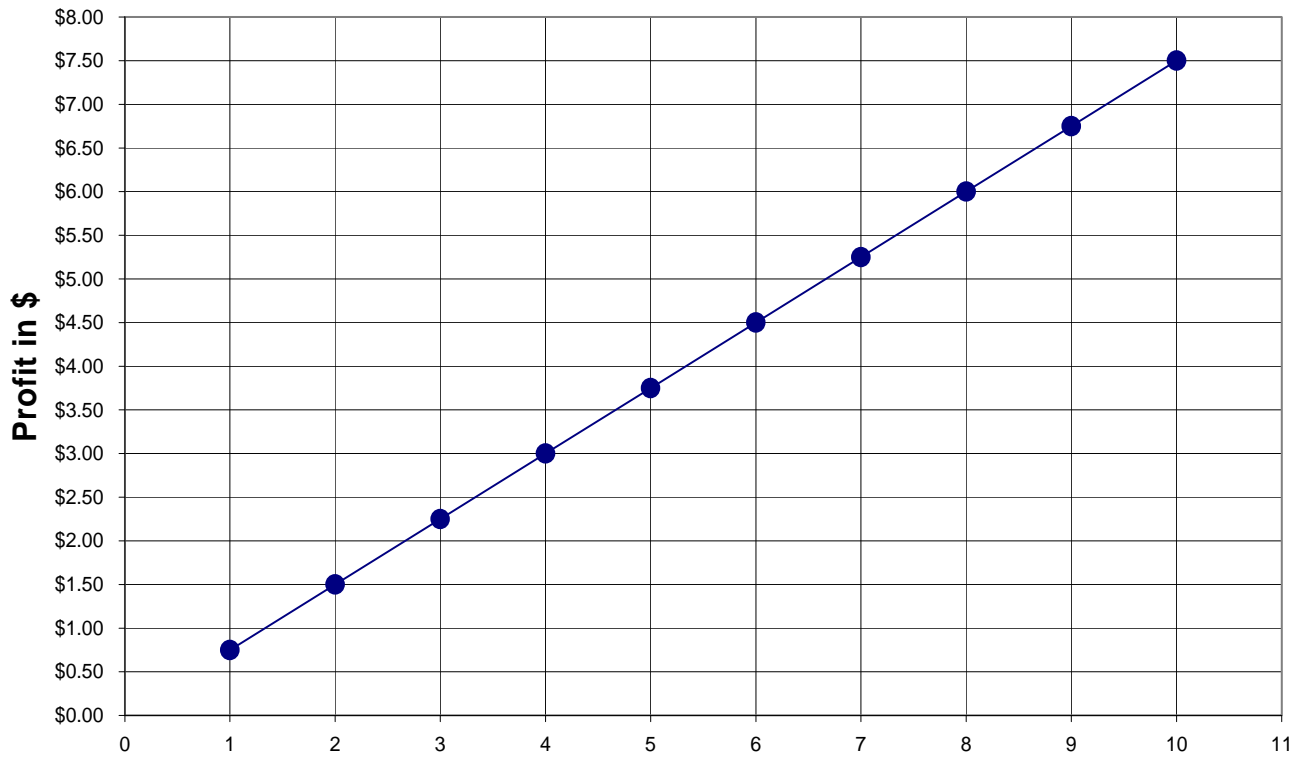
Circle the letter that shows the correct rule to fit the table.

- a. Input - 25
- b. Input + 11
- c. Input – 11
- d. Input – 15

The equation is _____

Student Resource 7a





Name: _____

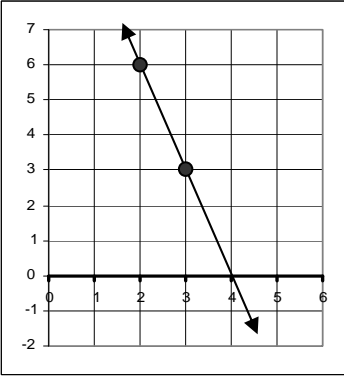
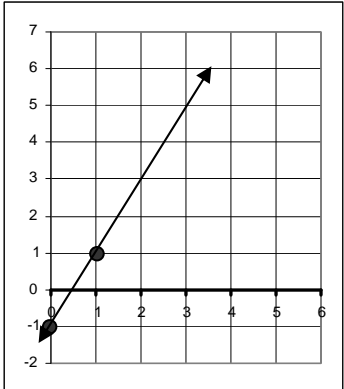
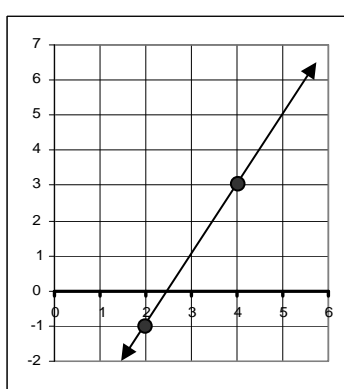
Bringing it All Together

As the store continues to sell items, we can see how much profit is generated each day and how many days it will take them to reach our goal of \$250. We can see how the changes we made can help us reach the goal more quickly.

| Item | Starting Profit | Amount Sold in 1 Week | Rule | Equation | Total Profits for Week | Change in Profit | New Profits for Week |
|--------------------------------|-----------------|-----------------------|------|----------|------------------------|------------------|----------------------|
| Pencil (P) | \$0.10 | 150 | | | | \$0.25 | |
| Pencil Topper (T) | \$0.13 | 100 | | | | | |
| Water Bottle (W) | \$0.60 | 25 | | | | | |
| Science Fair Boards (S) | \$1.00 | 12 | | | | | |
| Lanyard (L) | \$0.75 | 18 | | | | | |
| Totals | | | | | | | |

Matching Equations, Tables, and Graphs

Match each equation with its corresponding table and graph:

| Equation | Table | Graph | | | | | | | | |
|---|--|-------|---|---|---|---|----|---|----|---|
| <div>E1</div> <div>$y = 2x - 1$</div> | <div>T1</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>5</td><td>5</td></tr><tr><td>9</td><td>13</td></tr><tr><td>6</td><td>7</td></tr></tbody></table> | x | y | 5 | 5 | 9 | 13 | 6 | 7 | <div>G1</div>  |
| x | y | | | | | | | | | |
| 5 | 5 | | | | | | | | | |
| 9 | 13 | | | | | | | | | |
| 6 | 7 | | | | | | | | | |
| <div>E2</div> <div>$y = 2x - 5$</div> | <div>T2</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>1</td><td>9</td></tr><tr><td>4</td><td>0</td></tr><tr><td>0</td><td>12</td></tr></tbody></table> | x | y | 1 | 9 | 4 | 0 | 0 | 12 | <div>G2</div>  |
| x | y | | | | | | | | | |
| 1 | 9 | | | | | | | | | |
| 4 | 0 | | | | | | | | | |
| 0 | 12 | | | | | | | | | |
| <div>E3</div> <div>$y = 12 - 3x$</div> | <div>T3</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>3</td><td>5</td></tr><tr><td>2</td><td>3</td></tr><tr><td>4</td><td>7</td></tr></tbody></table> | x | y | 3 | 5 | 2 | 3 | 4 | 7 | <div>G3</div>  |
| x | y | | | | | | | | | |
| 3 | 5 | | | | | | | | | |
| 2 | 3 | | | | | | | | | |
| 4 | 7 | | | | | | | | | |

Write the matches below:

E1 matches _____ and _____

E2 matches _____ and _____

E3 matches _____ and _____

Name _____

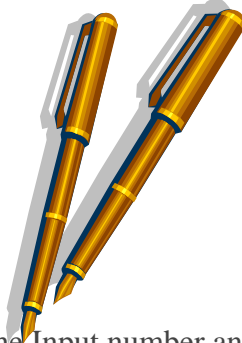
Student Resource 11a

School Store Success Summative Assessment

1. Michelle created the function table below of pens sold in the school store.



| Input | Output |
|-------|--------|
| 2 | 3 |
| 4 | 6 |
| 5 | 8.5 |
| 8 | 12 |
| 11 | |



Part A:

Which of these statements correctly describes the relationship between the Input number and the Output number?

- A. multiply by 2
- B. multiply by 1.5
- C. divide by 1.5
- D. multiply by 3

Part B:

Fill in the missing blank in the output column.

Part C

Use what you know about function tables to explain why your answer in Part B is correct. Use numbers and/or words in your explanation.

2. During the week 100 people visited the school store. On Monday, 22 people went to the school store. On Tuesday, 26 people came to the school store. On Wednesday, 24 more people came and on Thursday 19 more people came.

Part A

Write an equation showing the number of people at the school store on Friday. Let F represent Friday.

Part B

How many people visited the school store on Friday? Use what you know about algebraic equations to explain why your answer in Part A is correct. Use numbers and/or words in your explanation.



3. Part A

Complete each function table and write a rule below.

| In (X) | Out (Y) |
|--------|---------|
| 2 | 30 |
| 3 | 45 |
| 5 | 75 |
| 8 | |

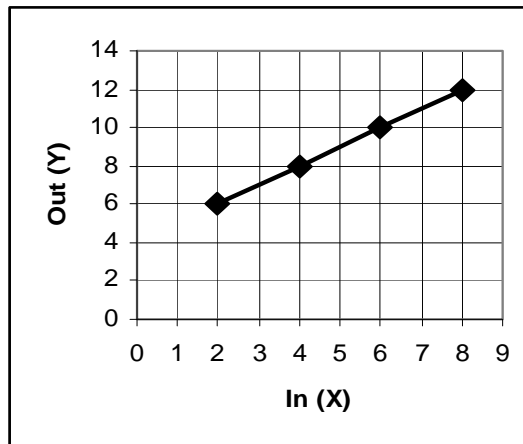
| In (X) | Out (Y) |
|--------|---------|
| | 0 |
| 15 | 8 |
| 18 | 11 |
| 25 | 18 |

| In (X) | Out (Y) |
|--------|---------|
| 1 | 5 |
| 5 | 9 |
| 10 | |
| | 20 |

a) _____ b) _____ c) _____

Part B

Which function table in Part A has the data correctly graphed below? Use what you know about graphing functions to explain why your answer is correct. Use numbers and/or words in your explanation.



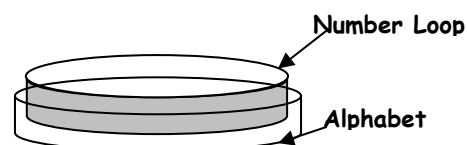
Variable Machine

Cut out the table below and then cut each column it into separate strips so that you have three alphabet strips and three number strips. For each variable machine you need one alphabet strip and one number strip. Start by using the number strip with the counting numbers. The other two number strips can be used for additional examples or enrichment.

Attach the ends of the alphabet strip together with tape to form a loop. The blank space at the bottom of the strip can be tucked under and used to attach the ends. Then do the same thing to the number strip. Put the number strip loop inside the alphabet loop and line them up so that the number 1 is directly across from the letter A. As you work through the activity, have students turn the number strip and line the number 1 up against different letters of the alphabet to show that the letters can represent different things.

| | | | | | |
|---|----|---|------|---|-------|
| A | 1 | A | .10 | A | 25.7 |
| B | 2 | B | .15 | B | 24.9 |
| C | 3 | C | .20 | C | 44.32 |
| D | 4 | D | .25 | D | 46.89 |
| E | 5 | E | .30 | E | 6.789 |
| F | 6 | F | .35 | F | 43.7 |
| G | 7 | G | .40 | G | 89.0 |
| H | 8 | H | .45 | H | 0.34 |
| I | 9 | I | .50 | I | 23.67 |
| J | 10 | J | .55 | J | 34.5 |
| K | 11 | K | .60 | K | 12.5 |
| L | 12 | L | .65 | L | 11.67 |
| M | 13 | M | .70 | M | 12.67 |
| N | 14 | N | .75 | N | 52.09 |
| O | 15 | O | .80 | O | 16.89 |
| P | 16 | P | .85 | P | 208.6 |
| Q | 17 | Q | .90 | Q | 35.78 |
| R | 18 | R | .95 | R | 4.557 |
| S | 19 | S | 1.00 | S | 6.908 |
| T | 20 | T | 1.05 | T | 0.345 |
| U | 21 | U | 1.10 | U | 5.78 |
| V | 22 | V | 1.15 | V | 2.567 |
| W | 23 | W | 1.20 | W | 75.34 |
| X | 24 | X | 1.25 | X | 832.9 |
| Y | 25 | Y | 1.30 | Y | 23.45 |
| Z | 26 | Z | 1.35 | Z | 43.67 |
| | | | | | |

The Variable Machine was adapted from *Navigating through Algebra in Grades 3-5*, pp 39-40.



School Store Success Vocabulary

Variable - A letter or symbol that stands for one or more numbers.

Example:

Independent Variable - X is a given and stands on its own.

Dependent Variable - Y depends on the value of X.

$X + 2 = Y$ If X equals 1 then Y will equal 3.

$X - 3 = Y$ If X equals 6 then Y will equal 3.

Expression - A mathematical phrase that combines numbers, operation signs, and sometimes **variables**, but doesn't have an equal sign.

Examples:

$3 \times (2 + 6)$ $4 + n$ $4 + 3$ $9 - 2$

Equation: A mathematic sentence that shows that two quantities or expressions are equal.

Examples:

$3 + 7 = n$ n is the same value in each equation.

$n - 1 = 9$

$15 + n = 25$

Function: A relationship between two quantities in which one quantity depends on the other. The relationship follows a rule in which there is only one output for each input.

Function Table: A table that matches each input value of a function with an output value. The output values are determined by the **function**.

Example: $y = 6x + 3$

| | | | | | |
|---|---|----|----|----|-----|
| x | 0 | 5 | 10 | 15 | 20 |
| y | 3 | 33 | 63 | 93 | 123 |

Graph:

A pictorial representation of information or mathematical relationships.

Evaluate:

Substitute given numbers for the variables and perform the operations to solve the problem.

What is a Variable?
Answer Sheet

Name: _____

What is a variable?

Possible Answers: **A variable is a letter or symbol that stands for one or more numbers. A variable is a symbol that changes value depending on other factors. Letters or symbols that stand for numbers that can change, or numbers that are unknown in a problem.**

Alan bought 6 erasers more than Sara. Use a variable to write an expression showing how many erasers Alan bought.

6S

Sales Each Day Story Problems

The School Store sold a certain number of pencils, eraser toppers and lanyards each day. Looking at our store sales results, you can see how many total items sold each day. We have given you clues to use to figure out how many of each specific item sold each day. (You may use colored chips or counters to represent the items.)

P = pencils

E = eraser toppers

L = lanyards

1. On Monday The Store Sold:

3 pencils

2 more eraser toppers than pencils

15 items in all

Write an equation using variables to determine the number of eraser toppers and lanyards sold on Monday.

Answer:

| | Pencils | Eraser Toppers | Lanyards |
|--------|---------|----------------|----------|
| Step 1 | 3 | $P + 2$ | L |
| Step 2 | 3 | 5 | L |

$$\underline{3 + P + 2 + L = 15 \quad \text{or} \quad 15 - (3 + (P + 2)) = L}$$

Pencils: 3 Eraser Toppers: 5 Lanyards: 7

2. On Tuesday The Store Sold:

6 pencils

Twice as many lanyards as eraser toppers

12 items in all

Write an equation using variables to determine the number of eraser toppers and lanyards sold on Tuesday.

Answer:

| | Pencils | Eraser Toppers | Lanyards |
|--------|---------|----------------|----------|
| Step 1 | 6 | E | 2E |

$$\underline{6 + E + 2E = 12 \quad \text{or} \quad 12 - 6 = E + 2E}$$

Pencils: 6 Eraser Toppers: 2 Lanyards: 4

3. On Wednesday The Store Sold:
3 pencils
4 times as many eraser toppers as pencils
23 items in all

Write an equation using variables to determine the number of eraser toppers and lanyards sold on Wednesday.

Answer:

| | Pencils | Eraser Toppers | Lanyards |
|----------|-------------------|---------------------------|--------------------|
| Step 1 | 3 | 4P | L |
| Step 2 | 3 | 12 | L |
| <hr/> | | | |
| | $3 + 12 + L = 23$ | | |
| Pencils: | <u>3</u> | Eraser Toppers: <u>12</u> | Lanyards: <u>8</u> |

4. On Thursday The Store Sold:
12 items in all
 $\frac{1}{4}$ of the items were pencils
 $\frac{1}{3}$ were lanyards

Write an equation using variables to determine the number of pencils, eraser toppers and lanyards sold on Thursday.

Answer:

| | Pencils | Eraser Toppers | Lanyards |
|----------|-----------------------------------|--------------------------|-----------------------------------|
| Step 1 | $\frac{1}{4} \times 12$ (or 12/4) | E | $\frac{1}{3} \times 12$ (or 12/3) |
| Step 2 | 3 | e | 4 |
| <hr/> | | | |
| | $3 + E + 4 = 12$ | | |
| Pencils: | <u>3</u> | Eraser Toppers: <u>5</u> | Lanyards: <u>4</u> |

5. On Friday The Store Sold:

1 fewer pencil than the number of erasers

1 fewer lanyard than the number of pencils

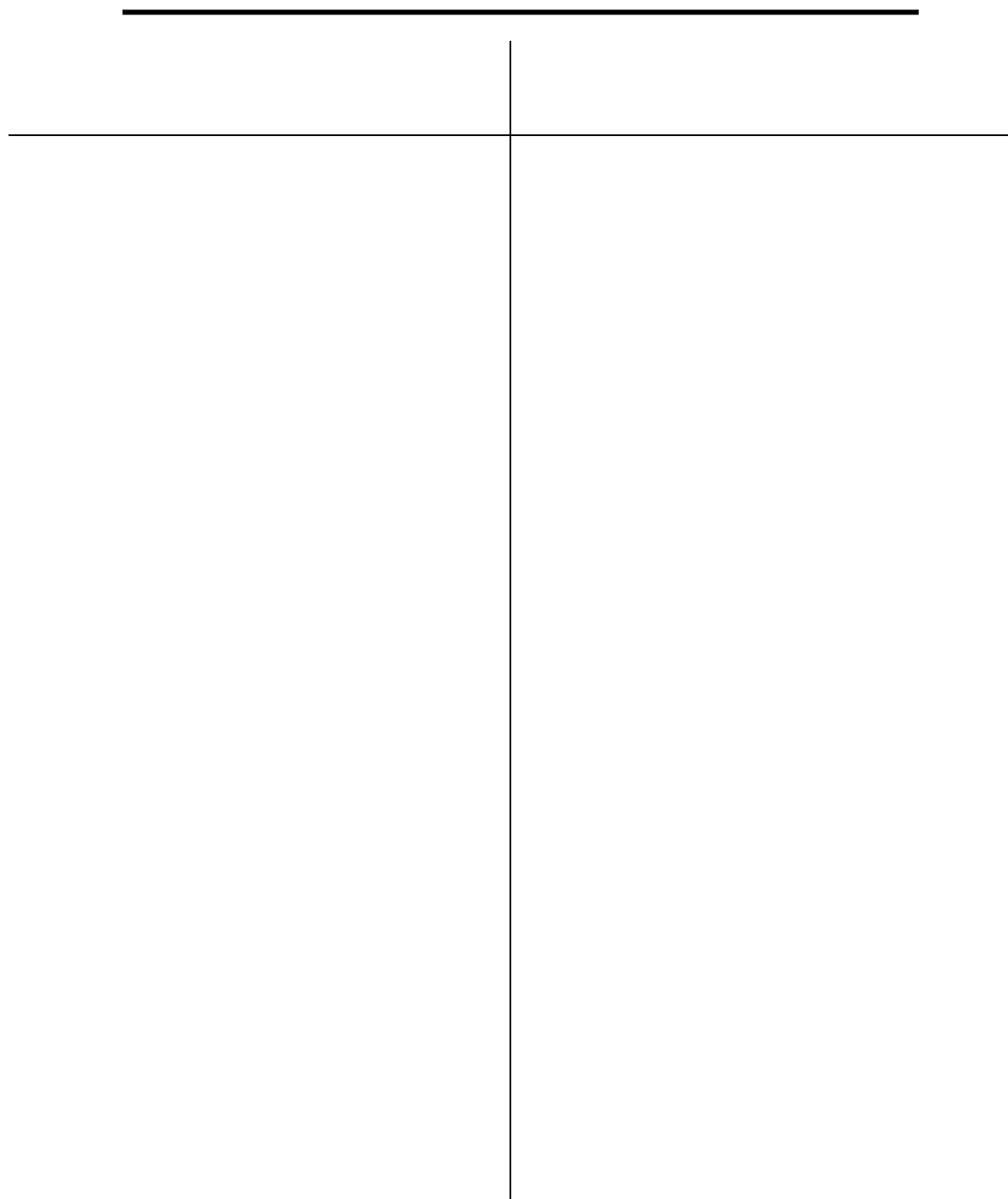
6 items in all

Write an equation using variables to determine the number of pencils, eraser toppers and lanyards sold in all.

Answer:

| | Pencils | Eraser Toppers | Lanyards |
|---------------|---------------------------|-----------------------|---------------------------------|
| Step 1 | $e - 1$ | e | $(e - 1) - 1$ |

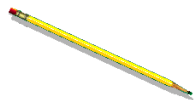



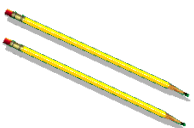



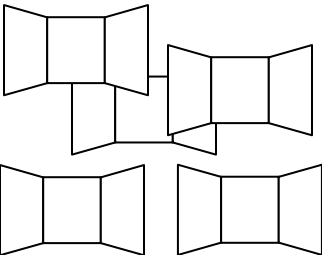
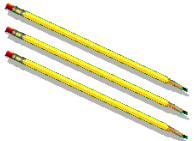
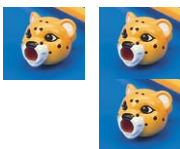


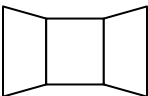
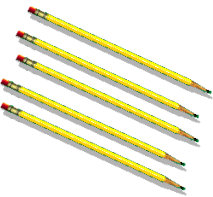
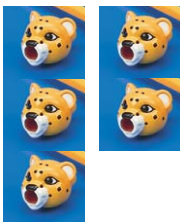


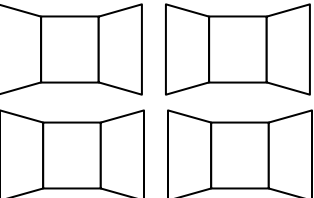
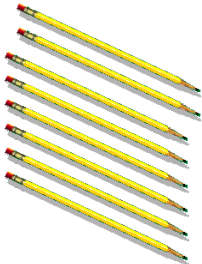
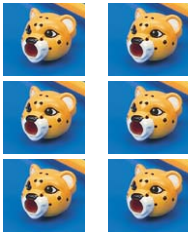


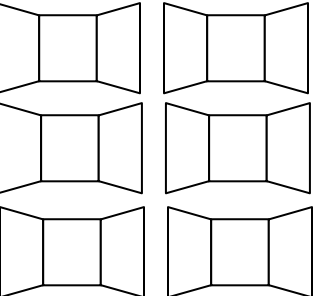
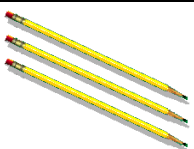
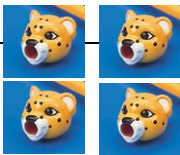

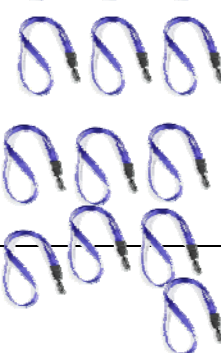
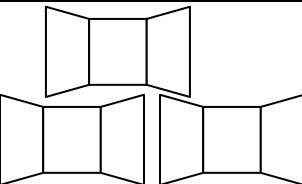
| | | |
|---|-----------------|---------------------------------|
| $6 = (e-1) + e + ((e-1) - 1)$ | | |
| Pencils: | <u>2</u> | Eraser Toppers: <u>3</u> |
| | | Lanyards: <u>1</u> |



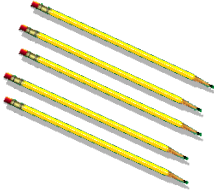


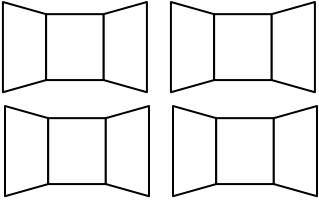
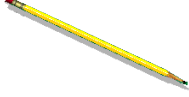



Rule:




































Equation:

Teacher Resource 6

| Pencils | Pencil Toppers | Water Bottles | Lanyards | Science Fair Boards |
|---|---|---|--|---|
|  |  |  |  | |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
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|  |  |  |  |  |

Variable Review Pre-Assessment
How Many Pencils Did We Sell?

We want to know how many pencils we sold in our school store. Write an equation using variables to help you find out.

Clues:

We sold 6 more Water Bottles than pencils.

We sold 2 times as many erasers as pencils.

We sold 2 lanyards more than the number of erasers.

We sold the same number of science fair boards as Lanyards.

The total amount of items sold in the store was 130.

Pencils = P

Water Bottles = W

Pencil Toppers = T

Lanyards = L

Science Fair Boards = S

Using the table below, write an expression for each item to show how many we sold.

| Pencils | Water Bottles | Erasers | Lanyards | Science Fair Boards |
|---------|---------------|---------|----------|---------------------|
| P | P + 6 | 2P | 2P + 2 | 2P + 2 |

Equation: $P + (P + 6) + 2P + (2P + 2) + (2P + 2) = 130$

$$\begin{array}{rclcl} 8P & + & 10 & = & 130 \\ & - & 10 & & - 10 \end{array}$$

$$8P = 120$$

$$P = 15$$

Solve the Equation and write your answers in the table below.

| Pencils | Water Bottles | Erasers | Lanyards | Science Fair Boards |
|---------|---------------|---------|----------|---------------------|
| 15 | 21 | 30 | 32 | 32 |

Check your answer:

$$\begin{array}{rcl} 15 + 21 + 30 + 32 & = & 130 \\ 130 & = & 130 \end{array}$$

Profitability Chart
for 1 of each item

| Items in the Store | Cost to Purchase | Price we Sell For | Profit |
|----------------------------|------------------|-------------------|---------------|
| Pencil | \$0.15 | \$0.25 | \$0.10 |
| Pencil Toppers | \$0.12 | \$0.25 | \$0.13 |
| Science Fair Boards | \$3.00 | \$4.00 | \$1.00 |
| Water Bottles | \$0.90 | \$1.50 | \$0.60 |
| Lanyards | \$1.25 | \$2.00 | \$0.75 |

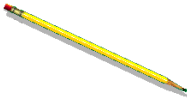

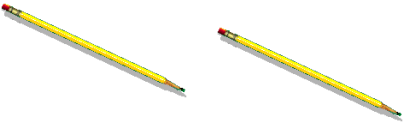

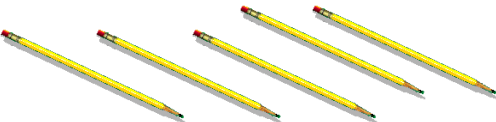

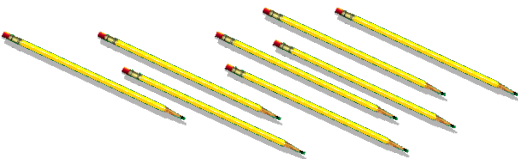

Function Table for Pencils

| INPUT | OUTPUT |
|-------|--------|
| | |
| | |
| | |
| | |
| | |
| | |

Rule: _____

Equation: _____

Function Table for Pencil

| INPUT | OUTPUT |
|--|---|
|  |  |
|  |  |
|  |  |
|  |  |
| | |

Input x \$0.10

Rule:

$\$0.10x = y$

Equation:

Name: _____

Rule and Sales Tracking Chart

Use this chart to summarize the rules generated for each item. Now we can project profits.

| Item | Starting Profit | Amount Sold in 1 Week | Rule | Equation | Total Profits for Week |
|--------------------------------|-----------------|-----------------------|------|----------|------------------------|
| Pencil (P) | \$0.10 | 150 | | | |
| Pencil Topper (T) | \$0.13 | 100 | | | |
| Water Bottle (W) | \$0.60 | 25 | | | |
| Science Fair Boards (S) | \$1.00 | 12 | | | |
| Lanyard (L) | \$0.75 | 18 | | | |
| Totals | | | | | |

Teacher Resource 11b**Name:** _____**Rule and Sales Tracking Chart Answer Key****Use this chart to summarize the rules generated for each item. Now we can project profits.**

| Item | Starting Profit | Amount Sold in 1 Week | Rule | Equation | Total Profits for Week |
|--------------------------------|-----------------|-----------------------|-----------------------|----------------------------------|------------------------|
| Pencil (P) | \$0.10 | 150 | Input x \$0.10 | $\\$0.10x = y$ | \$15.00 |
| Pencil Topper (T) | \$0.13 | 100 | Input x \$0.13 | $\\$0.13x = y$ | \$13.00 |
| Water Bottle (W) | \$0.60 | 25 | Input x \$0.60 | $\\$0.60x = y$ | \$15.00 |
| Science Fair Boards (S) | \$1.00 | 12 | Input x \$1.00 | $\\$1.00x = y$ | \$12.00 |
| Lanyard (L) | \$0.75 | 18 | Input x \$0.75 | $\\$0.75x = y$ | \$13.50 |
| Totals | | | | | \$68.50 |

Name: _____

Function Tables and Rules Review Answer Key

1. Complete the Function Table and write the Rule and Equation.

| Input (x) | Output (y) |
|--------------|---------------|
| 3 | 18 |
| 6 | 36 |
| 12 | 72 |
| 9 | 54 |
| 17 | 102 |

The rule is Input x 6The equation is $6x = y$

2. Complete the Function Table, match the table to the correct Rule, write the Equation.

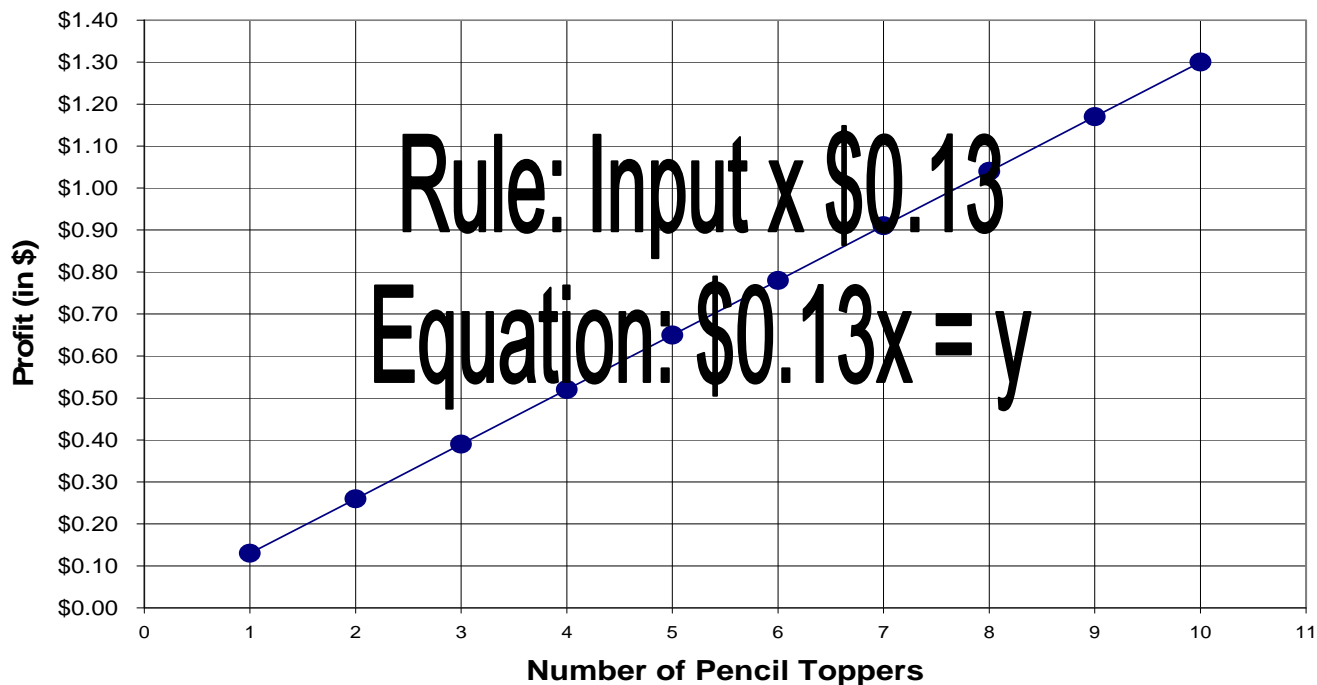
| Input (x) | Output (y) |
|--------------|------------|
| 18 | 7 |
| 26 | 15 |
| 41 | 30 |
| 36 | 25 |
| 25 | 14 |
| 57 | 68 |

Circle the letter that shows the correct rule to fit the table.

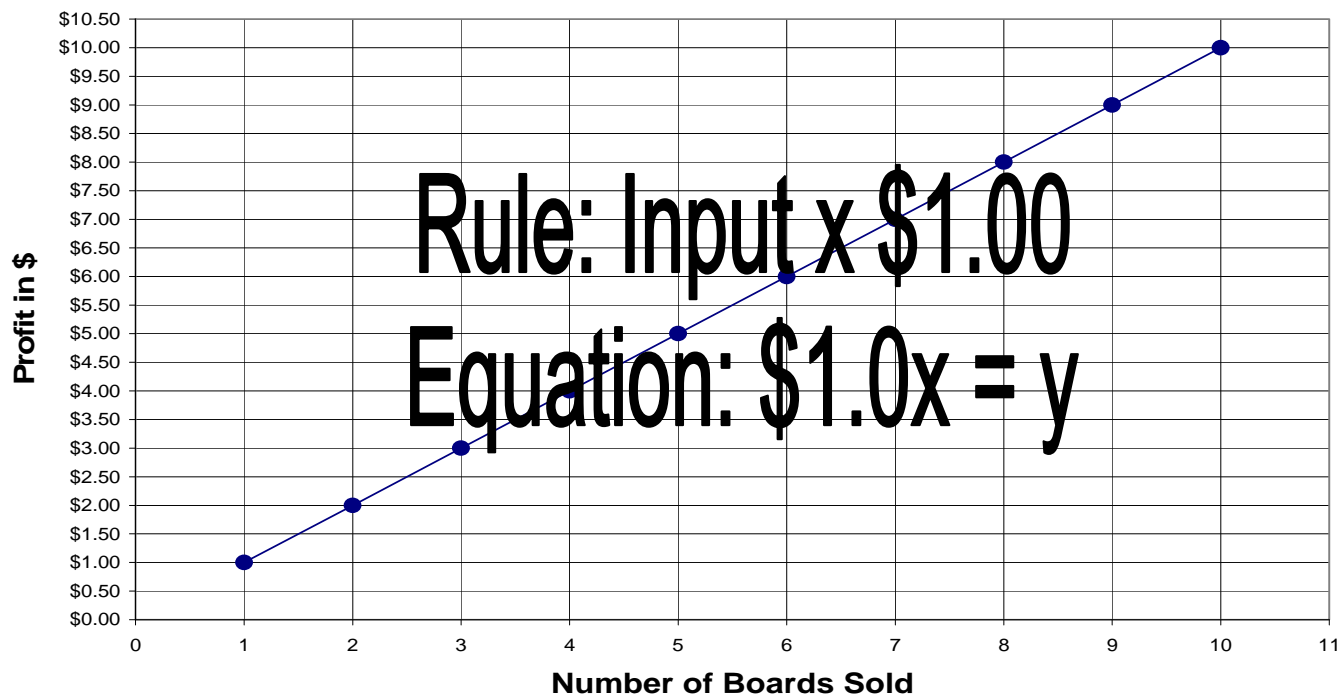
- a. Input - 25
- b. Input + 11
- c. Input - 11
- d. Input - 15

The equation is $x - 11 = y$

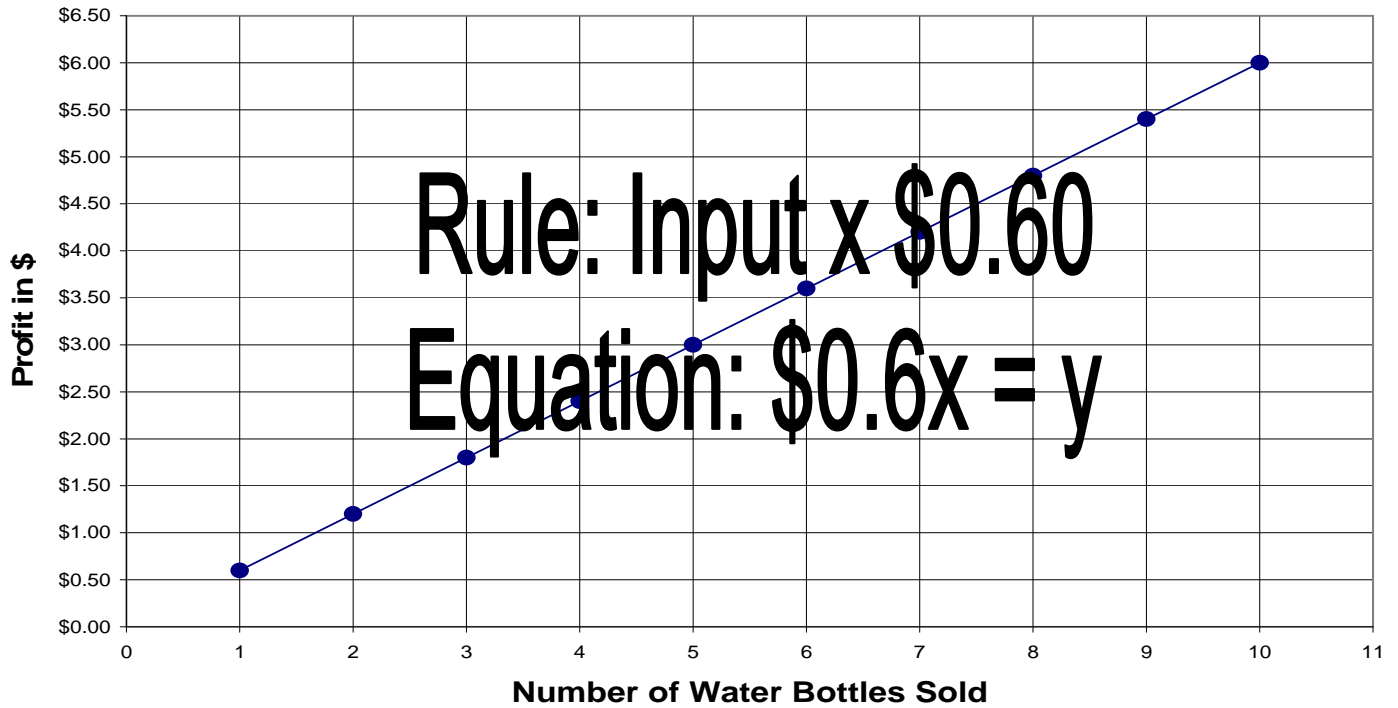
Pencil Topper Profits



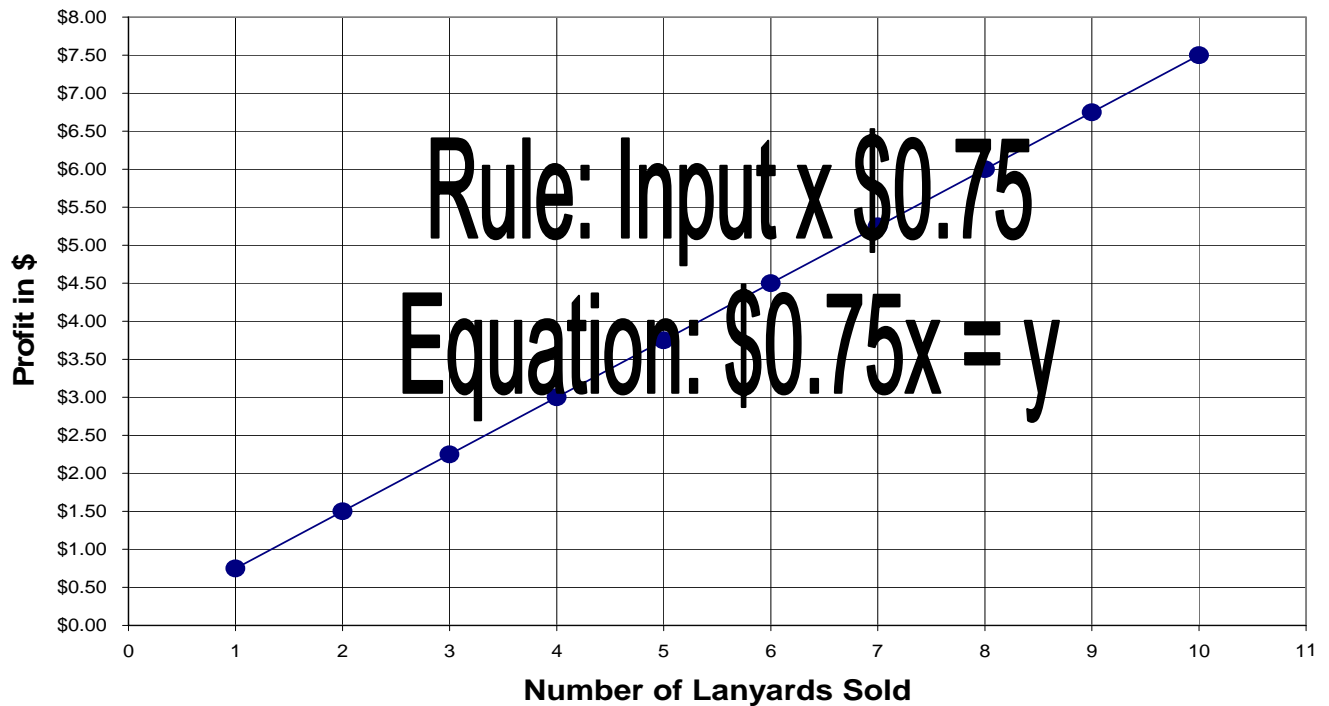
Display Board Profits

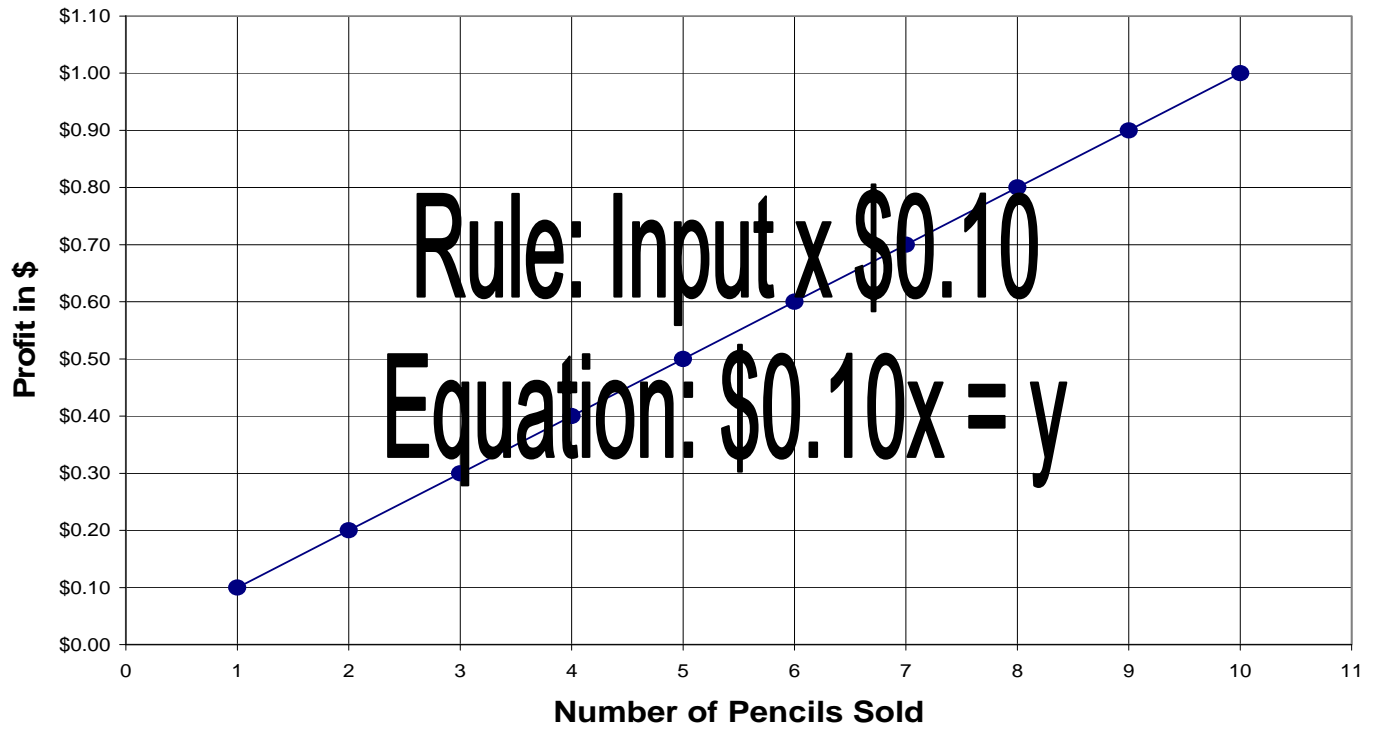


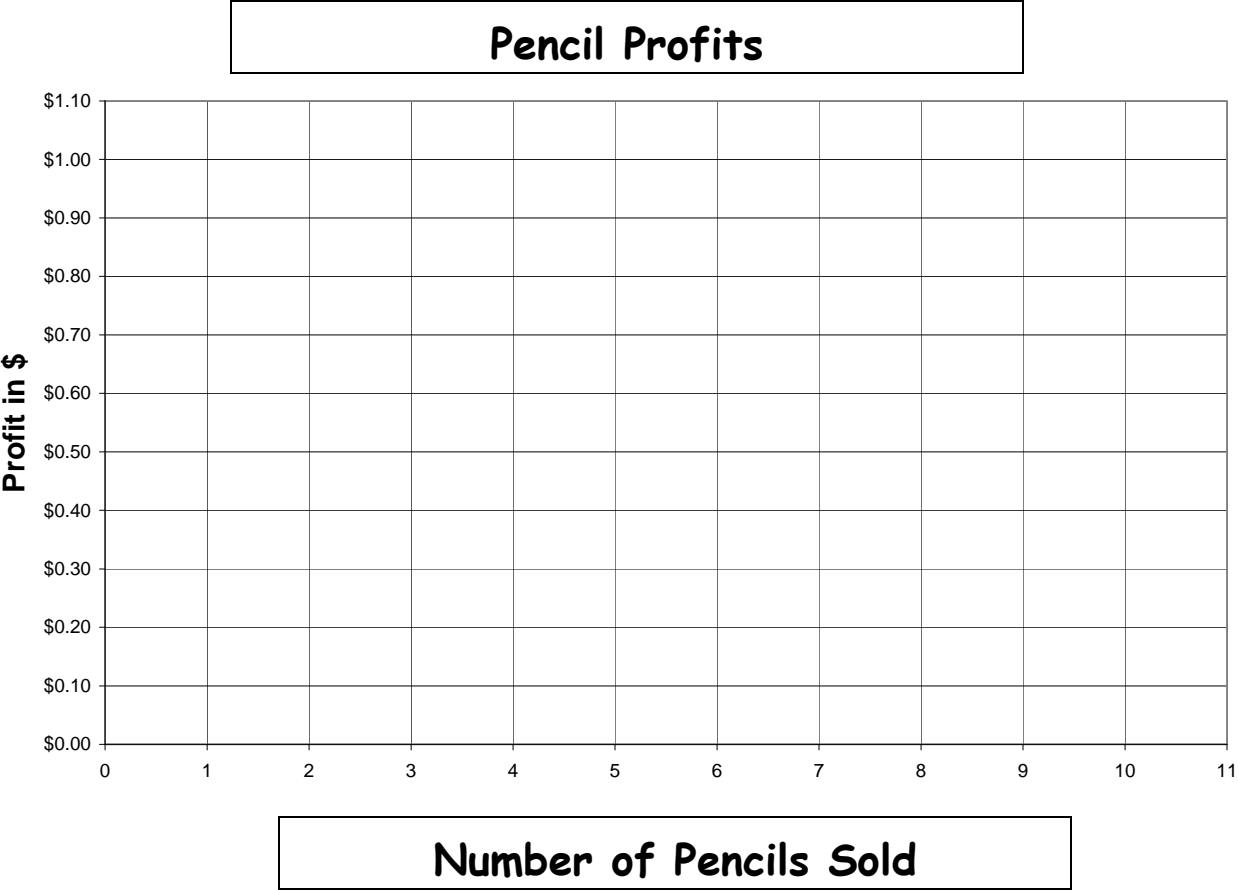
Water Bottle Profits

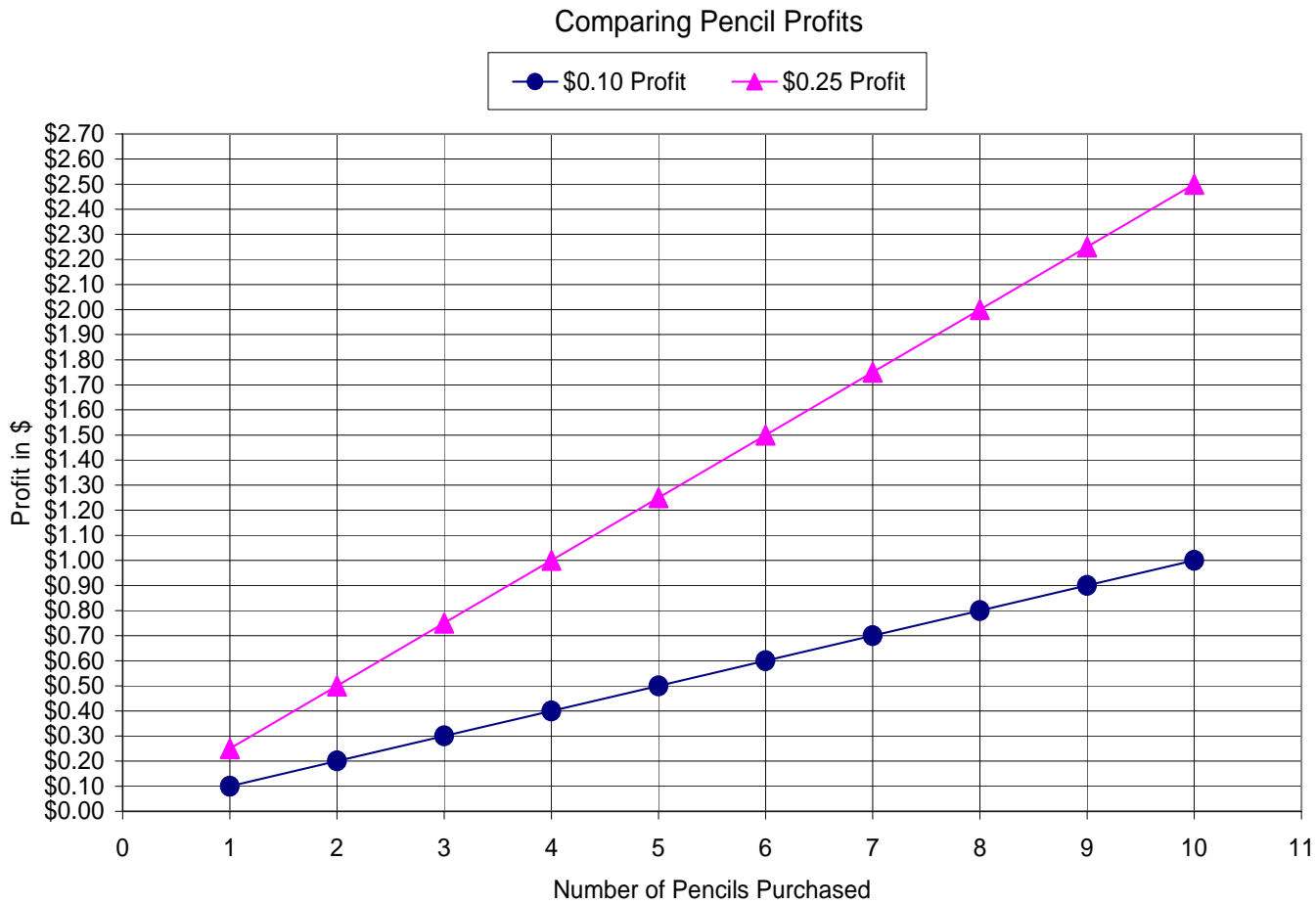


Lanyard Profits



Pencil Profits





Teacher Resource 16

Bringing it All Together Answer Key

As the store continues to sell items, we can see how much profit is generated each day and how many days it will take them to reach our goal of \$250. We can see how the changes we made can help us reach the goal more quickly.

| Item | Starting Profit | Amount Sold in 1 Week | Rule | Equation | Total Profits for Week | Change in Profit | New Profits for Week |
|-------------------------|-----------------|-----------------------|----------------|---------------|------------------------|------------------|----------------------|
| Pencil (P) | \$0.10 | 150 | Input x \$0.10 | $\$0.10x = y$ | \$15.00 | \$0.25 | \$ 37.50 |
| Pencil Topper (T) | \$0.13 | 100 | Input x \$0.13 | $\$0.13x = y$ | \$13.00 | | |
| Water Bottle (W) | \$0.60 | 25 | Input x \$0.60 | $\$0.60x = y$ | \$15.00 | | |
| Science Fair Boards (S) | \$1.00 | 12 | Input x \$1.00 | $\$1.00x = y$ | \$12.00 | | |
| Lanyard (L) | \$0.75 | 18 | Input x \$0.75 | $\$0.75x = y$ | \$13.50 | | |
| Totals | | | | | \$68.50 | | |

The numbers for these columns should be taken from the students' work at the beginning of this lesson. Each team decided on a new profit

Matching Equations, Tables, and Graphs

Match each equation with its corresponding table and graph:

| Equation | Table | Graph | | | | | | | | |
|---|--|-------|---|---|---|---|----|---|----|---------------|
| <div>E1</div> <div>$y = 2x - 1$</div> | <div>T1</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>5</td><td>5</td></tr><tr><td>9</td><td>13</td></tr><tr><td>6</td><td>7</td></tr></tbody></table> | x | y | 5 | 5 | 9 | 13 | 6 | 7 | <div>G1</div> |
| x | y | | | | | | | | | |
| 5 | 5 | | | | | | | | | |
| 9 | 13 | | | | | | | | | |
| 6 | 7 | | | | | | | | | |
| <div>E2</div> <div>$y = 2x - 5$</div> | <div>T2</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>1</td><td>9</td></tr><tr><td>4</td><td>0</td></tr><tr><td>0</td><td>12</td></tr></tbody></table> | x | y | 1 | 9 | 4 | 0 | 0 | 12 | <div>G2</div> |
| x | y | | | | | | | | | |
| 1 | 9 | | | | | | | | | |
| 4 | 0 | | | | | | | | | |
| 0 | 12 | | | | | | | | | |
| <div>E3</div> <div>$y = 12 - 3x$</div> | <div>T3</div> <table><thead><tr><th>x</th><th>y</th></tr></thead><tbody><tr><td>3</td><td>5</td></tr><tr><td>2</td><td>3</td></tr><tr><td>4</td><td>7</td></tr></tbody></table> | x | y | 3 | 5 | 2 | 3 | 4 | 7 | <div>G3</div> |
| x | y | | | | | | | | | |
| 3 | 5 | | | | | | | | | |
| 2 | 3 | | | | | | | | | |
| 4 | 7 | | | | | | | | | |

Write the matches below:

E1 matches T3 and G2 E2 matches T1 and G3 E3 matches T2 and G1

School Store Success Summative Assessment

1. Michelle created the function table below of pens sold in the school store.

| Input | Output |
|-------|--------|
| 2 | 3 |
| 4 | 6 |
| 5 | 8.5 |
| 8 | 12 |
| 11 | 16.5 |

Part A

Which of these statements correctly describes the relationship between input number and the Output number?

- E. multiply by 2
- F. multiply by 1.5
- G. divide by 1.5
- H. multiply by 3

Part B

Fill in the missing blank in the output column.

Part C

Use what you know about function tables to explain why your answer in Part B is correct. Use numbers and/or words in your explanation.....

Refer to Teacher Resource 19, MSA BCR Rubric to evaluate written response. Part C is

worth 2 points.

Student Resource 18b

2. During the week 100 people visited the school store. On Monday, 22 people went to the school store. On Tuesday, 26 people came to the school store. On Wednesday, 24 more people came and on Thursday 19 more people came.

Part A

Write an equation showing the number of people at the school store on Friday. Let F represent Friday. *Possible solutions:* $22 + 26 + 24 + 19 + F = 100$

$$F = 100 - 22 - 26 - 24 - 19$$

Part B

How many people came to the store on Friday? Use what you know about algebraic equations to explain why your answer in Part A is correct. Use numbers and/or words in your explanation.

9 people. Refer to Teacher Resource 19, MSA BCR Rubric to evaluate the written response. Part B is worth 3 points. 1 point for correctly identifying 9 people and 2 points for a thorough explanation.

3. Part A

Complete each function table and write a rule below. (6 total points)

| In (X) | Out (Y) |
|--------|---------|
| 2 | 30 |
| 3 | 45 |
| 5 | 75 |
| 8 | 120 |

| In (X) | Out (Y) |
|--------|---------|
| 7 | 0 |
| 15 | 8 |
| 18 | 11 |
| 25 | 18 |

| In (X) | Out (Y) |
|--------|---------|
| 1 | 5 |
| 5 | 9 |
| 10 | 14 |
| 16 | 20 |

a) $15x = y$

b) $x - 7 = y$

c) $4 + x = y$

Part B

Which function table in Part A has the data correctly graphed below? Use what you know about graphing functions to explain why your answer is correct. Use numbers and/or words in your explanation.

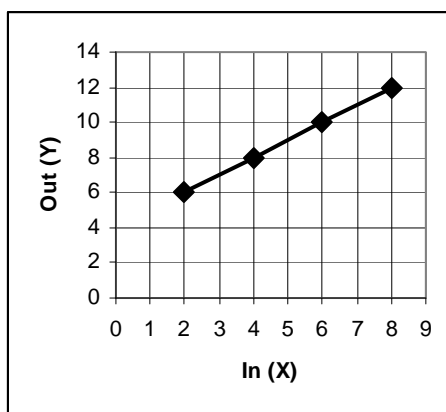


Table C. Refer to Teacher Resource 19, MSA BCR Rubric to evaluate written response. Part B is worth 3 point. 1 point for correctly identifying table C and 2 points for a thorough explanation.

MSA Brief Constructed Response “Kid Speak”
Mathematics Rubric
Grades 1 through 8

| Score | |
|----------|---|
| 2 | <p>My answer shows I completely understood the problem and how to solve it:</p> <ul style="list-style-type: none"> • I used a very good, complete strategy to correctly solve the problem. • I used my best math vocabulary to clearly explain what I did to solve the problem. My explanation was complete, well organized and logical. • I applied what I know about math to correctly solve the problem. • I used numbers, words, symbols or pictures (or a combination of them) to show how I solved the problem. |
| 1 | <p>My answer shows I understood most of the problem and how to solve it:</p> <ul style="list-style-type: none"> • I used a strategy to find a solution that was partly correct. • I used some math vocabulary and most of my reasons were correct to explain how I solved the problem. My explanation needed to be more complete, well organized or logical. • I partly applied what I know about math to solve the problem. • I tried to use numbers, words, symbols or pictures (or a combination of them) to show how I got my answer, but these may not have been completely correct. |
| 0 | <p>My answer shows I didn’t understand the problem and how to solve it:</p> <ul style="list-style-type: none"> • I wasn’t able to use a good strategy to solve the problem. • My strategy wasn’t related to what was asked. • I didn’t apply what I know about math to solve the problem. • I left the answer blank. |